



C program library

For TASKING Inc. MCS[®] 251 8x930 USB software

Author: Walter Banks, Jr.

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Introduction

This document summarizes the C library programs which a software developer can use when building embedded applications for Intel's 8x930Hx and Ax Universal Serial Bus (USB) peripheral controllers. This document summarizes the C library programs, describes vendor-specific implementations and lists the C programs. Many of these implementations are compiler specific; hence, this document focuses on the TASKING Inc.'s software tools for Intel's MCS® 251 8x930 USB products. This document describes each compiler-specific implementation.

The major sections in this document are:

Requirements List - Defines the requirements to which the C programs were developed. The programs conform to the requirements defined in this section.

C Programs Summary - Provides a high-level description of each program.

Programming Details - Defines the syntax, commands and keywords used in this document.

C Programs - Contains a complete listing for each program. The program names are:

- C_ASSBLY.C
- INTERUPT.C
- PCA.C
- PORTS.C
- SER_COM.C
- SERIAL.C
- SFR_MEM.C
- TIMER0.C
- TOOLS.C
- VAR_MEM.C
- WDT.C

Related Information

Document Name 8x931AA, 8x931HA Universal Serial Bus Peripheral Controller User's Manual

Order Information Call Intel's literature center 1-800-548-4725, order number 273102

Intel Web location <http://developer.intel.com/design/usb>

TASKING Web location <http://www.tasking.nl>

Requirements List

C items for embedded controller programming

1. Writing code to exercise the Special Function Registers:
 - 1.1. Reading and storing to the Special Function Registers
 - 1.2. Writing and changing Special Function Registers contents
2. Writing code to exercise the peripherals:
 - 2.1. Setting up the timer/counters in different modes
 - 2.2. Setting up the watch dog timer
 - 2.3. Setting up the PCA
 - 2.4. Using the serial port in different modes
3. Reading from and writing to memory (RAM):
 - 3.1. Placing variables into specified memory locations
 - 3.2. Locating tables into specified memory locations
 - 3.3. Copying data from internal memory to external memory
 - 3.4. Copying data from external memory to internal memory
4. Dealing with Interrupts:
 - 4.1. Code for internal and external interrupt service routines
 - 4.2. Setting up interrupt priorities
 - 4.3. Disabling and enabling interrupts
5. Using the ports on the peripheral controller:
 - 5.1. Sending information to the ports
 - 5.2. Reading information from the ports
 - 5.3. Reading from and writing to individual port pins
6. C and Assembly:
 - 6.1. Using assembly code for a specific task (e.g. a timing loop)
 - 6.2. Using assembly code inside C programs
 - 6.3. Using conditional assembly

C compiler examinations

1. Testing operators:
 - 1.1. Arithmetic operators
 - 1.2. Increment and decrement operators
 - 1.3. Bit wise AND, OR and exclusive OR operators
 - 1.4. ones complement
 - 1.5. Left-shift and Right-shift operators
 - 1.6. Relational operators
 - 1.7. Logical operators
2. Program looping:
 - 2.1. Using the FOR statement
 - 2.2. The infinite loop
 - 2.3. Using the WHILE statement and DO-WHILE construction
3. Program Branching:
 - 3.1. Using the IF statement
 - 3.2. Constructions with the IF-ELSE statements
 - 3.3. The SWITCH statement
 - 3.4. The GOTO statement
4. Arrays:
 - 4.1. Creating and initializing arrays
 - 4.2. Multidimensional arrays
5. Strings:
 - 5.1. Initializing strings
 - 5.2. Printing strings (using printf, puts, etc.)
6. Functions:
 - 6.1. Programs with multiple Functions
 - 6.2. Using Local, Static and Global variables
 - 6.3. Parameter passing between functions
 - 6.4. Recursive functions
7. Structures:
 - 7.1. Initializing structures
 - 7.2. Structures within structures
 - 7.3. Structures containing arrays
8. Pointers
 - 8.1. Basic pointer usage
 - 8.2. Passing arguments by value or by argument
 - 8.3. Pointers to Character Arrays

C Programs Summary

C_ASSBLY.C

This program demonstrates how Assembly language is implemented in C programs (in-line Assembly). The program first examines port P1 (LEDs are connected to this port) and determines if any bits have a logic 1 level. When a bit with logic 1 level is detected, the program executes code which drives P1 to a logic 0, then to logic 1 (LEDs blink off, then on). When bits of P1 are at the logic 0 level, the program executes code which drives P1 to logic 1, then to logic 0 (the LEDs blink on, then off). Once P1 is examined then toggled, the code executes an endless loop. The details of using Assembly in C are described in the *Programming Details* section and in the program C_ASSBLY.C.

INTERUPT.C

This program demonstrates how to enable and disable interrupts in C and shows how to implement interrupt service routines for external and internal interrupts. The program code also shows how to set interrupt priorities. In the program, an interrupt is generated by setting the timer and allowing it to time out. The program jumps to the interrupt service routine where LEDs are illuminated to verify that the interrupt service routine has executed successfully. While in the internal interrupt service routine, the program enters an infinite loop at which time the user can generate an external interrupt by use of an external interrupt source (as described in the Intel 8x931AA, 8x931HA *Universal Serial Bus Peripheral Controller User's Manual* external interrupt section). Once the external interrupt is generated, the program goes into the external interrupt service routine and the LEDs are illuminated to verify the interrupt service routine has executed successfully. The interrupt vector numbers starting address is configured in the TASKING target configuration window. The details of implementing interrupts in C are shown in the *Programming details* section and in the program INTERUPT.C.

PCA.C

This program demonstrates how to implement the Programmable Counter Array (PCA) in a C program. In the program, the PCA is set as a firmware timer. Executing the code causes the timer to time out which generates the PCA interrupt. The service routine for this interrupt causes the LEDs to illuminate which indicates the routine has executed correctly. The details of how to set up the PCA in C are shown in the program PCA.C.

PORTS.C

This program demonstrates how the 8x930xx ports can be accessed in a C program. The program uses structures to allow access to the ports and the individual port pins. The program reads the ports' status and prints it to the terminal. The value of port 0 is read and a new value is written to the port by external means. The new value of port 0 is then printed to the terminal. The details of accessing the ports are shown in the program PORTS.C.

SER_COM.C

This program shows how to use the serial communications port to transmit and receive data. The program transmits a simple message to the internal serial port. The message can be viewed with the Microsoft Windows* terminal application or any application that can allow connections through a PC's serial communication port. The program then enables the serial port interrupt, which allows the user to enter characters via the keyboard. When a character is entered it is incremented to the next character (e.g., "a" is incremented to "b") and then printed to the terminal. The details of using the serial communication port are shown in the *Programming details* section and in the program SER_COM.C.

SERIAL.C

Use this program to set the serial port up for communications with the terminal. The program has one function (no main function) which can be called by other programs to set up the internal serial port for communication, using timer 2 as the baud rate generator. Due to the speed required for the other serial port modes and the terminal limitations, other serial modes are not used. The details of setting up the serial port for communications are shown in the *Programming details* section and in the program SERIAL.C.

SFR_MEM.C

This program demonstrates one of two methods for storing to and reading from the special function registers (SFRs) to specific memory locations. This method uses pointers while the other method uses keywords included with the software for this purpose. In the program, ten pointers are assigned specific memory addresses. The SFRs and last five pointers are initialized. The contents of the SFRs used in the program are written to the first five pointers. The contents of the memory addresses specified by the last five pointers are placed in the SFRs that are used in the program. The program validates the values that are written and read to ensure they are correct. If the numbers are incorrect, the program enters an infinite loop which causes the program to stop executing. The details of using the pointers to write and read to specific memory locations is shown in the program SFR_MEM.C.

TIMER0.C

This program demonstrates the implementation of Timers in C programming. The user is prompted to select the desired timer mode. Once this selection is made, the timer begins to run in that mode. The timer times out, generating an interrupt. The interrupt service routine illuminates the LEDs to confirm that the routine has executed correctly. This program requires the use of the internal serial port connected to the serial port of a PC. The details of setting up Timer0 are shown in the program TIMER0.C.

TOOLS.C

This program demonstrates the implementation of strings, structures, switch and case statements as well as printing (printf) to and reading (scanf) from the terminal. The program requests information from the user — such as the user's name, company and USB HUB peripheral controller requirements — and stores the data in a structure. The program recommends to the user a USB HUB peripheral controller that suits their requirements using a switch and case statement. The program outputs to the terminal the user's name, company, device requirements and the recommended device. This program requires the use of the internal serial port connected to the serial port of a PC. The details of printing and reading strings to and from the terminal through the serial port are shown in the *Programming details* section and in the program TOOLS.C.

VAR_MEM.C

This program demonstrates the second of two methods for accessing specific memory locations. This method does not use pointers; it uses keywords included with the software for the use of storing data to known memory locations. The program:

- stores variables and values into specified memory locations.
- writes internal memory to external memory, and external memory to internal memory.
- stores a one dimensional array of numbers and a two-dimensional array of numbers starting at specific addresses.

The LEDs illuminate to indicate that program execution has completed. Use the debugger to view the data memory to confirm that the correct data was written to the correct addresses. The details of accessing specific memory locations are shown in the *Programming details* section and in the program VAR_MEM.C.

WDT.C

This program demonstrates how the Watch Dog Timer (WDT) is configured in a C program. The program sets up the timer, which causes the timer to run. After an arbitrary number of refreshes the timer times out, which resets the device, thus resetting the evaluation board. The board does not reset until the program halts. Because the reset is not generated by the debugger, the software has no indication that the system has been reset. The only visible evidence that the system has been reset is the LED sequence associated with board reset. The details of setting up the Watch Dog Timer are shown in the program WDT.C.

Programming Details

Certain applications of C programming are specific to the TASKING development tools. The correct implementation of certain functions or applications in C for the TASKING software tools are described in the following subsections.

In - line Assembly

The Assembly code is delineated by the ASM and ENDASM directives. The form is:

```
#pragma asm

    assembly code

#pragma endasm
```

Interrupts

The **_interrupt** keyword tells the compiler that the function is an interrupt service routine. The number inside the parentheses (#) tells the compiler the vector number for the function. The number for the interrupt vectors is found at the end of the Reg930hx.SFR file found in the include directory. The name of the interrupt service routine follows the vector number. A format example for an interrupt service routine is:

```
void _interrupt(#) void ISR(void)
{
    C code;
}
```

Serial Communications

Using the serial port for communications requires that specific registers contain specific values so the baud rate will be set correctly. The correct baud rate ensures the serial port transmits and receives correctly. The function used to set the baud rate provided in this document is called serialSetup in the SERIAL.C program. The SERIAL.C program uses timer 2 to generate the baud rate of 9600.

Serial Communications - output

Outputting data through the serial communications port to the terminal at a rate of 9600 baud requires that a delay be present between the transmission of each character. The serial port interrupt bit must *not* be enabled for serial port output transmissions because an interrupt will be generated when data is transmitted. If no serial port interrupt service routine exists, the program may deliver unexpected results. An example of this follows:

```
char out[21];
short cnt, delayCnt;
out = "This how to output text";
for (cnt = 0; cnt < 21; cnt++)
{
    SBUF = out[cnt];
    for (delayCnt = 0; delayCnt < 7000; delayCnt++);
}
```

Serial Communications - input

Inputting data through the serial communications port to the terminal at a rate of 9600 baud requires that the serial port interrupt bit be enabled. Between reception and transmission, an instruction — such as writing a value to a port — must be inserted for delay purposes. An example of this follows:

```
char in;
in = SBUF;
RI = 0;
PI = 0xF2;
in++;
SBUF = in;
TI = 0;
```

Serial Communications - printf, puts

Using the C functions **prints** and **puts** to output characters to the terminal is the same as described in the preceding section (Serial communications - output). The TI bit must be set (TI = 1) before these functions are called. An example of this follows:

```
#include<sio.h>
char text[40];
init_uart();
text = "This is how it is done with puts"
TI = 1;
printf("This how it is done with printf");
puts(text);
```

Serial Communications - scanf

Using the C function **scanf** to input characters from the terminal is different from just inputting characters through the serial port. The TI bit must be set (TI = 1) because this function prints back to the screen what the user has entered on the keyboard. The ES (serial port interrupt) bit must **not** be enabled. An example of this follows:

```
#include<sio.h>
short input;
init_uart();
TI = 1;
scanf("%d", &input);
```

Memory Access

As is true for assembly language programming, specific memory addresses can be accessed in C by other means than with the use of pointers. Memory is accessed using the **at** keyword. Using this memory access method, the memory locations cannot be initialized. A separate function must be used to initialize the memory locations. An example of memory access is:

```
_data unsigned char mem at (0x70);
void main(void)
{
    varInitialize();
}
void varInitialize (void)
{
    mem1 = 0x50;
}
```

C Programs

C_ASSBLY.C

```

/*****
 *This program is used to show how to implement in-line
 *assembly in C source code. This program checks to see if
 *any of the bits of the Port P1 are pulled high and makes
 *a jump based on the port value. The LEDs are illuminated
 *to verify that the jumps were made to the correct
 *location.
 *****/
void main(void)
{
    /*The LEDs are illuminated to show the start of execution.*/
    P1 = 0xF1;

    /*The beginning of the in-line assembly code.*/
    #pragma asm
        MOV R3, P1
        CMP R3, #00h      ;The port P1 is checked to determine if they
are illuminated.
        JE LIGHTS         ;If the leds are not illuminated then jump
to LIGHTS.
        JMP NOLIGHTS      ;If the leds are illuminated jump to
NOLIGHTS.
        LIGHTS:           ;The leds are turned on and then turned off.
            MOV WR8, #0EFFh
            LP1:
                MOV P1, #0FFH ;A delay is inserted so the LEDs can be seen
                CMP WR8, #00H
                DEC WR8, #01H
                JNE LP1
                MOV P1, #00H
                JMP FINISH

        NOLIGHTS:         ;The leds are turned off and then turned on.
            MOV WR8, #00FEFFh
            LP2:
                MOV P1, #00H ;A delay is inserted so the LEDs are seen.
                CMP WR8, #00H
                DEC WR8, #01H
                JNE LP2
                MOV P1, #0FFH

        FINISH:
        /*End of the in-line assembly code.*/
        #pragma endasm
        while(1);
}

```

INTERRUPT.C

```

/*****
 *This program is used to show how interrupts are
 *set up in C as well as how to create functions
 *which are interrupt service routines. The
 *altering of interrupt priority is also shown in
 *this program.
 *
 *Timer 1 is set up as a 16 bit timer
 *and then allowed to time out with its interrupt
 *being enabled. This generates an interrupt and
 *the code immediately jumps to the interrupt
 *vector where the service routine is located.
 *While in the timer service routine an external
 *interrupt is generated via the INT1# pin. The
 *LEDs are illuminated to show the service routine
 *has been executed properly.
 *
 *Interrupt name      Interrupt vector
 *PCA                 0x0033
 *Timer 2             0x002B
 *Serial Port         0x0023
 *Timer 1             0x001B
 *INT1#               0x0013
 *Timer 0             0x000B
 *INT0 #              0x0003
 *****/

#include <Reg930hx.sfr>
#include <Reg930ax.sfr>
#define DELAY 20000

void main(void)
{
    /*The port 3 bit 3 is set so that the pin can function as the
    external interrupt 1 pin.*/
    P3 |= 0x04;

    /*TMOD register is used to set Timer 1 as mode 1 -> 16 bit timer*/
    TMOD = 0x01;

    /*Timer 1 interrupt is enabled and the timer is turned on.*/
    ET1 = 1;
    TR1 = 1;
    while(1);
}

/*Internal interrupt (Timer 1) service routine.*/
_interrupt(3) void timer1ISR(void)
{
    short cnt;

    /*Timer 1 is turned off*/

```

```
TCON &= 0xBF;;

/*The LEDs are turned on with delays so there will be visible proof
that the ISR was executed.*/
for(cnt = 0; cnt < DELAY; cnt++)
    P1 = 0x0F;
for(cnt = 0; cnt < DELAY; cnt++)
    P1 = 0x70;
for(cnt = 0; cnt < DELAY; cnt++)
    P1 = 0x55;

/*The external interrupt priority is made high*/
IPH0 |= 0x04;
IPL0 |= 0x00;

/*External interrupt is set level triggered.*/
TCON &= 0xFB;

/*External interrupt 1 is enabled*/
EX1 = 1;

while(1);
}

/*External interrupt 1 service routine.*/
_interrupt(0) void extISR(void)
{
    short cnt;

    /*The interrupt request is cleared.*/
    IE1 = 0;

    /*The LEDs are written to so that there will be visible proof that
    the interrupt service routine was executed*/
    for(cnt = 0; cnt < DELAY; cnt++)
        P1 = 0x01;
    for(cnt = 0; cnt < DELAY; cnt++)
        P1 = 0x02;
    for(cnt = 0; cnt < DELAY; cnt++)
        P1 = 0x04;
    for(cnt = 0; cnt < DELAY; cnt++)
        P1 = 0x04;
    for(cnt = 0; cnt < DELAY; cnt++)
        P1 = 0x08;
    for(cnt = 0; cnt < DELAY; cnt++)
        P1 = 0x10;
    for(cnt = 0; cnt < DELAY; cnt++)
        P1 = 0x20;
    for(cnt = 0; cnt < DELAY; cnt++)
        P1 = 0x40;
    while (1);
}
```


PCA.C

```

/*****
 *The programmable counter array performs a variety of timing*
 *and counting operations, including pulse width modulation *
 *and also provides the capability of a firmware watchdog    *
 *timer. The PCA is setup in the following code as a         *
 *firmware timer. A value is placed in the compare register  *
 *and when the timer reaches that value an interrupt is      *
 *generated and the code jumps to the interrupt service     *
 *routine for the PCA.                                       *
 *****/
#include<Reg930hx.sfr>
#define DELAY 10000

void main(void)
{
    /*PCA compare/capture register is configured as a firmware timer
    with compare flag enabled. */
    CCAPM0 = 0x49;

    /*PCA Timer/Counter mode register set input signal as Fclk/6. */
    CMOD = 0x80;

    /*The PCA Timer/Counter interrupt is disabled. */
    EC = 0;

    /*An interrupt is generated when the timer reaches the value in the
    compare registers CCAPxH,CCAPxL.*/
    CCAP0L = 0x11;
    CCAP0H = 0xCF;

    /*The PCA timer/counter interrupt is enabled and the timer is turned
    on.*/
    EC = 1;
    CR = 1;
    while (1);
}

/*Interrupt service routine for the PCA 16 bit firmware timer.*/
_interrupt(6) void pcaISR(void)
{
    long cnt;

    /*The timer is turned off and the interrupt request is cleared.*/
    CCON = 0x00;

    /*The LEDs are written so that there will be visible proof
    that the interrupt service routine was executed.*/
    for(cnt = 0; cnt <= DELAY; cnt++)
        P1 = 0x01;
    for(cnt = 0; cnt <= DELAY; cnt++)
        P1 = 0x02;
    for(cnt = 0; cnt <= DELAY; cnt++)
        P1 = 0x04;
    for(cnt = 0; cnt <= DELAY; cnt++)
        P1 = 0x08;
    while(1);
}

```

PORTS.C

```
/*
*****
*This program is used to read and write to some of the
*ports of the device and to output a text string through
*the serial port to a terminal. Individual port pins will
*be accessed as well. The port status is read and printed.
*****
*/

#include<stdio.h>
#include<string.h>
#define TRUE 1
#define FALSE 0

extern void serialSetup(void);

char* portName0;

typedef struct
{
    char* port;
    short portStatus;
    short portNumber;
    short bit0:1;
    short bit1:1;
    short bit2:1;
    short bit3:1;
    short bit4:1;
    short bit5:1;
    short bit6:1;
    short bit7:1;
}ports;

void serialPrint(ports portOutput, short printLimit);
void readBit(ports portsBit);

void main(void)
{
    ports portP0;

    serialSetup();

    /*Port P0 status is defined.*/
    portP0.port = "P0";
    portP0.portStatus = P0;
    portP0.portNumber = 0x00;
    portP0.bit0 = P0,0;
    portP0.bit1 = P0,1;
    portP0.bit2 = P0,2;
```

```

    portP0.bit3 = P0,3;
    portP0.bit4 = P0,4;
    portP0.bit5 = P0,5;
    portP0.bit6 = P0,6;
    portP0.bit7 = P0,7;

    printf("%s, the port status is %d\n", portP0.port,
    portP0.portStatus);
    readBit(portP0);
    portP0.portStatus = P0;
    printf("%s, the port status is now %d.\n", portP0.port,
    portP0.portStatus);
while(1);
}

void readBit(ports portsBit)
{
    short oldValue0;

    oldValue0 = P0;

    portName0 = "P0";

    printf("\r\nNow the user can change the port values by an external\
voltage source.\r\n\n");

    if (!strcmp(portsBit.port, portName0, 2))
        while (P0 == oldValue0);
}

```

SER_COM.C

```

/*****
 *The serial port which is used to communicate with the*
 *outside world can be set up in different modes.      *
 *There is one synchronous mode and three asynchronous *
 *modes.                                                *
 *MODE 0 = half duplex, synchronous mode used to expand*
 *           the capability of a I/O device with shift  *
 *           registers; Baud rate = Fclk/6              *
 *MODE 1 = full duplex, asynchronous mode;             *
 *           Baud rate = variable                       *
 *MODE 2 = full duplex, asynchronous mode;             *
 *           Baud rate = Fclk/16 or Fclk/32            *
 *MODE 3 = full duplex, asynchronous mode;             *
 *           Baud rate = variable                      *
 *****/
/*****
 *This program is used to test the serial communications of the *
 *internal serial port. The serial port is set up by the SERIAL.C*
 *program which has a function serialSetup which is called and *
 *sets the necessary baud rate using timer 2. A message is      *
 *printed to the terminal and characters are read in from the    *
 *keyboard and printed out again.                               *
 *****/
#include<Reg930hx.sfr>
#include<stdio.h>
#include<string.h>
#define DELAY 7000

extern void serialSetup(void);
void serialPrint(char* outputText, short textLength);

void main(void)
{
    char* output;
    char* output1;
    char* output2;
    short length, length1, length2;

    /*Character pointers are initialized.*/
    output = "\r\nThis is a test, just a test.\r\n";
    length = strlen(output);
    output1 = "\r\nThis is cool\r\n";
    length1 = strlen(output1);
    output2 = "\r\nThis is not fun.\r\n";
    length2 = strlen(output2);

    serialSetup();
    serialPrint(output, length);
    serialPrint(output1, length1);
    serialPrint(output2, length2);
    ES = 1;
    P1 = 0xf1;
    while (1);
}

```

```

/*Interrupt service routine for the serial port input communications.*/
_interrupt(4) void internalSerialISR(void)
{
    if (RI == 1)
    {
        P1 = 0x0F;
        ACC = SBUF;
        RI = 0;
        P1 = ACC;
        ACC++;
        SBUF = ACC;
        TI = 0;
    }
    else
        TI = 0;
    return;
}

/*This is the function that is used to print to the terminal through the
internal serial port.*/
void serialPrint(char* outputText, short textLength)
{
    short cnt, delayCnt;
    static short counter = 0;

    for (cnt = 0; cnt < textLength; cnt++)
    {
        SBUF = outputText[cnt];
        TI = 0;

        /*A delay is inserted for the serial transmission.*/
        for (delayCnt = 0; delayCnt < DELAY; delayCnt++);
    }
    counter++;
    TI = 1;
    printf("\nThis print function has been called %d times.\n",
counter);
    return;
}

```

SERIAL.C

```

/*****
 *This program is used for setting up the serial port for *
 *communication. The program uses timer 2 to generate the*
 *baud rate of 9600. An external program calls the      *
 *serialSetup function to set up the baud rate generator *
 * which is timer 2.                                     *
 *****/
#include<Reg930hx.sfr>
#include<stdio.h>

void serialSetup(void)
{
    static short counter = 0;

    /*Timer 2 is disabled and set up as the baud rate generator for a 9600 baud
    rate with fclk = 12Mhz.*/
    TR2 = 0;

    /*Timer 2 Control register is set up for timer 2 operation.*/
    T2CON = 0x30;

    /*Timer 2 Reload/Capture registers set the baud rate for 9600.*/
    RCAP2H = 0xFF;
    RCAP2L = 0xEC;

    /*Power control register enables the low clock mode, so that the clock is 3
    MHz.*/
    PCON |= 0x20;

    /*Timer 2 is enabled.*/
    TR2 = 1;

    /*The serial port control register is set up for mode 1 operation*/
    SCON = 0x50;

    /*Serial port interrupt priority is set to 1 which is next to the lowest.*/
    PS = 1;

    /*The TI bit is set to allow for transmission.*/
    TI = 1;
    RI = 1;

    counter++;
    printf("\nThis serial port setup function has been called %d
    times.\n", counter);
    return;
}

```

SFR_MEM.C

```

/*****
 *This program is written to show access of the special
 *function registers by memory. The values in the
 *registers and memory locations are checked for accuracy.
 *If the program executes correctly then the last four
 *LEDs are illuminated. If the program does not execute
 *correctly then the program will not proceed pass the
 *point where the error is located.
 *****/

#include<Reg930hx.sfr>

void main(void)
{
    unsigned char* mem1;
    unsigned char* mem2;
    unsigned char* mem3;
    unsigned char* mem4;
    unsigned char* mem5;
    unsigned char* mem6;
    unsigned char* mem7;
    unsigned char* mem8;
    unsigned char* mem9;
    unsigned char* mem10;

    /*Memory pointers are assigned addresses, the pointers will point to these
    addresses.*/

    mem1 = (unsigned char*)0x60;
    mem2 = (unsigned char*)0x61;
    mem3 = (unsigned char*)0x62;
    mem4 = (unsigned char*)0x63;
    mem5 = (unsigned char*)0x64;
    mem6 = (unsigned char*)0x65;
    mem7 = (unsigned char*)0x66;
    mem8 = (unsigned char*)0x67;
    mem9 = (unsigned char*)0x68;
    mem10 = (unsigned char*)0x69;

```

```
/*Special function registers are initialized with arbitrary values.*/

/*The B register should have the value 0x04.*/
B = 0x34;
B &= 6;
if (B != (char)0x04)
    while(1);

/*The CCAP0H register should have the value 0x89.*/
CCAP0H = 0x89;
CCAP0H |= 8;
if (CCAP0H != (char)0x89)
    while(1);

/*The P1 register should have the value 0x42.*/
P1 = 0x53;
P1 ^= 0x17;
if (P1 != (char)0x44)
    while(1);

/*The DPH register should have the value 0x10.*/
DPH = 0x11;
DPH <= 4;
if (DPH != (char)0x10)
    while(1);

/*The CH register should have the value 0x10.*/
CH = 0x42;
CH >>= 3;
if (CH != (char)0x08)
    while(1);

/*Memory addresses are initialized with arbitrary values.*/

/*The address at mem6 should have the value 0xC7.*/
*mem6 = 0x23;
*mem6 *= 0x13;
*mem6 = 0x23 * 0x13;
if (*mem6 != (char)0x99)
    while(1);

/*The address at mem7 should have the value 0x05.*/
*mem7 = 0x24;
*mem7 /= 0x07;
if (*mem7 != (char)0x05)
    while(1);
```



```

/*The address at mem8 should have the value 0x41.*/
*mem8 = 0x39;
*mem8 += 0x08;
if (*mem8 != (char)0x41)
    while(1);

/*The address at mem9 should have the value 0x5C.*/
*mem9 = 0x73;
*mem9 -= 0x17;
if (*mem9 != (char)0x5C)
    while(1);

/*The address at mem10 should have the value 0x06.*/
*mem10 = 0x0A;
*mem10 %= 0x3;
if (*mem10 != (char)0x01)
    while(1);

/*Special funtion register contents are written to memory.*/

/*The address at mem1 should have the value 0x10.*/
B = 0x04;
*mem1 = B << 2;
if (*mem1 != (char)0x10)
    while(1);

/*The address at mem2 should have the value 0x43.*/
*mem2 = (unsigned char)CCAP0H >> 3;
if (*mem2 != (char)0x11)
    while(1);

/*The address at mem3 should have the value 0x02.*/
*mem3 = P1 & 0x32;
if (*mem3 != (char)0x00)
    while(1);

/*The address at mem4 should have the value 0x99.*/
*mem4 = DPH | 0x99;
if (*mem4 != (char)0x99)
    while(1);

/*The address at mem5 should have the value 0x23.*/
*mem5 = CH ^ 0x33;
if (*mem5 != (char)0x3B)
    while(1);

```

```

/*Memory contents are written to the special function registers.*/

    /*The B register should have the value 0xE3.*/
    B = *mem6 * 5;
    if (B != (char)0xFD)
        while(1);

    /*The CCAP0H register should have the value 0x01.*/
    CCAP0H = *mem7 / 5;
    if (CCAP0H != (char)0x01)
        while(1);

    /*The P1 register should have the value 0x45.*/
    P1 = *mem8 + 4;
    if (P1 != (char)0x45)
        while(1);

    /*The DPH register should have the value 0x59.*/
    DPH = *mem9 - 3;
    if (DPH != (char)0x59)
        while(1);

    /*The CH register should have the value 0x01.*/
    CH = *mem10 % 5;
    if (CH != (char)0x01)
        while(1);

/*The LEDs will stay illuminated once the program is complete.*/
    P1 = 0x0F;
    while(1);
}

```

TIMER0.C

```

/*****
 *This program sets up and test the modes of timer 0 by
 *prompting the user to enter which mode that they desire
 *timer 0 to be in, then timer 0 is set to that mode and
 *the timer 0 interrupt is enabled. When an interrupt is
 *generated the interrupt service routine is executed. The
 *LEDs are illuminated to show that the program has executed
 *correctly.
 *****/
#include<stdio.h>
#define DELAY 10000

```

```

short cnt;
extern void serialSetup(void);

void main(void)
{
    short mode;

    /*Serial communication is set up with this function and the TI bit must be
    set in the interrupt register.*/
    serialSetup();

    /*Print out the user menu and get the user's input.*/
    puts("\n\nThe following timer modes may be selected for
timer0\n\n");
    puts("Mode 0 - 13 bit timer\n");
    puts("Mode 1 - 16 bit timer\n");
    puts("Mode 2 - 8 bit timer with Auto-reload\n");
    puts("Mode 3 - two 8 bit timers\n");
    printf("Enter the Mode number that you would like timer 0 to be set
as and press \nenter: ");
    scanf("%d", &mode);
    printf("%d", mode);
    printf("\nThe number that is stored at the mode location is =
%d\n\n", mode);

    /*The timers are turned off in the Timer control register*/
    TCON = 0x00;

    /*The mode of timer 0 is set in the timer mode register.*/
    /*Mode 0 -> 13 bit timers*/
    if (mode == 0)
    {
        TMOD = 0x00;
        goto setbits;
    }

    /*Mode 1 -> 16 bit timers*/
    else if (mode == 1)
    {
        TMOD = 0x01;
        goto setbits;
    }

    /*Mode 2 -> 8 bit timer with Auto-reload*/
    else if (mode == 2)
    {
        TMOD = 0x02;
        goto setbits;
    }
}

```

```
/*Mode 3 -> two 8 bit timers*/
else if (mode == 3)
{
    TMOD = 0x03;
    goto setbits;
}

/*Incorrect mode is selected.*/
else
{
    puts("\n\nYou have enter the wrong value, reset and start
again.");
    while(1);
}

/*The interrupt for timer 0 is enabled and timer 0 is turned on.*/
setbits:
    ET0 = 1;
    TR0 = 1;
    while(1);
}

/*Interrupt service routine for timer 0.*/
_interrupt(1) timer0Isr(void)
{
    /*LEDs are turned on to show that interrupt service routine was
exectuted*/
    do
    {
        for (cnt = DELAY; cnt > 0; cnt--)
            P1 = 0x40;
        for (cnt = DELAY; cnt > 0; cnt--)
            P1 = 0x20;
        for (cnt = DELAY; cnt > 0; cnt--)
            P1 = 0x10;
        for (cnt = DELAY; cnt > 0; cnt--)
            P1 = 0x08;
    }
    while(1);
}
```

TOOLS.C

```

/*****
 *This program is used to examine how the software
 *interacts with stings and structures. The program
 *prompts the user to enter his/her name and then
 *enter the user's company as well as info about the
 *USB device needed. From this information the
 *program recommends to the user the USB controller
 *they should be using
 *****/
#include<Reg930hx.sfr>
#include<stdio.h>

/*Structure definition for the time of birth.*/
typedef struct
{
    short ports;
    char package[4];
    short romSize;
}device;

/*Structure definition for the day and time of birth.*/
typedef struct
{
    char company[30];
    char userName[20];
    device controller;
}profile;

extern void serialSetup(void);

void main(void)
{
    char* chip;
    profile userApp;

    serialSetup();

    puts("\n\nThis is the USB Hub product selector menu.\n");
    puts("\nProceed each entry with a 0\n");
    printf("Enter your first name: ");
    scanf("%s", userApp.userName);
    printf("%s", userApp.userName);
    printf("\nEnter the company that you represent: ");
    scanf("%s", userApp.company);
    printf("%s", userApp.company);
    puts("\nEnter the number of downstream ports you will be needing");
    printf("(4 ports or 3 ports): ");
    scanf("%d", &userApp.controller.ports);

```

```

        printf("\nEnter the desired package for the controller (PLCC or
SDIP): ");
        scanf("%s", userApp.controller.package);
        printf("%s", userApp.controller.package);
        puts("\nEnter the desired ROM size.");
        printf("i.e. 0, 8 or 16 (kbytes): ");
        scanf("%d", &userApp.controller.romSize);

        /*The user's device is determined.*/
        if (userApp.controller.ports == 3)
        {
            switch (userApp.controller.romSize)
            {
                case 0: chip = "80930HD";
                    break;
                case 8: chip = "80930HD";
                    break;
                case 16: chip = "8093HE";
                    break;
            }
        }
        else
        {
            switch (userApp.controller.romSize)
            {
                case 0: chip = "80930HF";
                    break;
                case 8: chip = "80930HF";
                    break;
                case 16: chip = "8093HG";
                    break;
            }
        }

        printf("\n%s, representing %s.", userApp.userName,
userApp.company);
        printf("\nThe microcontroller recommended for your application is
the %s\n",\
        chip);
        printf("in the %s package with %d downstream ports and %d kilobytes
size \
ROM.", userApp.controller.package, userApp.controller.ports,
userApp.controller.romSize);
        while(1);
    }

```

VAR_MEM.C

```

/*****
 *This program is used to show the implementation of
 *variables being located in memory as well as tables in
 *memory. Arbitrary values are written to a one
 *dimensional array and a two dimensional array.
 *
 *The memory can be accessed using _data, _bdat, _idat
 *_pdat, _xdat, _rom.
 *_data allows access to direct addressable on chip RAM.
 *_bdat allows access to bit addressable on chip RAM.
 *_idat allows access to indirect addressable on chip RAM.
 *_pdat allows access to paged external RAM within first 256 bytes.*
 *_xdat allows access to external RAM.
 *_rom allows access to internal/external ROM.
 *Each memory type is accessed in the same manner:
 *
 *      _data char variable at (address)
 *****/

#include<Reg930hx.sfr>
#define INDEX 0x09
#define INDEX2 0x03

void varInitialize(void);

/*The variable mem1 is placed into INTERNAL data address location 0x49.*/
_data unsigned char mem1 _at (0x49);

/*The variable mem2 is placed into EXTERNAL data address location 0x80.*/
_xdat unsigned char mem2 _at (0x80);

/*The array table[INDEX] is placed into INTERNAL data address location
0x40.*/
_data unsigned char table [INDEX] _at (0x40);

/*The array table2[INDEX][INDEX2] into INTERNAL data address location
0x4A.*/
_data unsigned char table2 [INDEX][INDEX2] _at (0x4A);

void main(void)
{
    short cnt, cnt2, addressIndex, addressIndex2;

    varInitialize();

```

```
/*One dimensional array is stored starting at data memory 0x40*/
for (cnt = 0x00; cnt < INDEX; cnt++)
{
    table[cnt] = 0x04 * cnt;
}

/*Multi-dimensional array is stored starting at data memory 0x60*/
for (cnt = 0x00; cnt < INDEX; cnt++)
{
    for (cnt2 = 0x00; cnt2 < INDEX2; cnt2++)
    {
        table2[cnt][cnt2] = 0x02 + cnt2;
    }
}

/*LEDs indicate that the program is complete.*/
P1 = 0xF1;

while(1);
}

void varInitialize(void)
{
    mem1 = 0x54;
}
```


WDT.C

```

/*****
 *The Watchdog timer is used to reset the chip is it is*
 *allowed to time out. It provides a means of recovery*
 *from routines that do not complete successfully. The*
 *timer must be refreshed so that it does not time out.*
 *The following program sets up the Watchdog timer and *
 *then after ten refreshes, allows it to time          *
 *out, which resets the system once the program is      *
 *halted.                                                *
 *****/
#include<Reg930hx.sfr>
#define DELAY 100

void main(void)
{
    short cnt, delayCnt;

    cnt = 0;
    ACC = 0x42;

    /*First this value is written*/
    WDTRST = 0x1E;

    /*Second this value is written, these values clear and enable the WDT and
    must be written to the periodically to the register before it overflows to
    start it again.*/
    WDTRST = 0xE1;

    do
    {
        WDTRST = 0x1E;
        WDTRST = 0xE1;
        for (delayCnt = 0; delayCnt < DELAY; delayCnt++);
        cnt++;
    }
    while(cnt < 6);

    while(1);
}

```